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AUTHOR	Duncan, Glenn E.; Bauch, Jerold P.
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ABSTRACT

Georgia Educational Models (GEM) will proceed to utilize computers and simulation to their fullest cost effectiveness potential simultaneously in operation and in research, while avoiding both the restrictions and duplications which come from doctrinaire insistence on maintaining an artificial separation between management and research uses of computer simulation models and the omissions and "illusions of adequacy" which come from too little interaction with empirical facts and goals. The fundamental scientific paradigm which has guided development and management of GEM thus far has proven itself practical, effective, and economical and has demonstrated itself to be feasible for carrying forth the further development, the implementation, and the sustained operation of the GEM system through creation and use of a computerized overall system simulation model. (Author/JS)

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GEORGIA EDUCATIONAL MODELS
The University of Georgia
College of Education
Athens, Georgia 30601

THE USE OF COMPUTERS AND SIMULATION IN THE DEVELOPMENT AND MANAGEMENT OF GEM

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Glenn E. Duncan, B.S.
Jerold P. Bauch, Ed.D.

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There has been little concensus in the literature to date as to just what the boundaries and interactions may be between such frequently mentioned fields as systems analysis, operations research, management science, simulation, automation, etc. After mentioning the physical models used in engineering, those who consider simulation alone usually restrict their definitions to the conducting of experiments with a mathematical, statistical, and/or logical representation of an idealized simplification of some portion of an existing or hypothetical system -- usually on a large, fast digital computer.

At what might be called the other extreme of a continuum, those who consider management alone define computerized accounting and data processing to be automation of processes within a system, even though these processes may be carried out on the same sort of computer and may utilize programs and subroutines logically identical to those used in simulation. A clear separation between these two extremes is not maintained in the discussions following such definitions, nor can it be maintained by consideration of purpose alone. It is more profitable to ask when, why, and how to use computers in a project.

Building a mathematical model, validating and optimizing the model on a computer, and finally implementing and

putting it into practice is a valid engineering strategy in a well-developed field. However, any approximation to this strategy is hazardous in a complex and partially-developed field such as education. Recent literature contains many discussions of specific results of doing this, such as over-fascination with computer gadgetry, attempts to predict the future in great detail from the past, ignoring of factors which can't be quantified, creation of procedures which "blow up" after great checkout expense when tried out for the first time on real data, etc. Perhaps all these ills and more are best summed up by Hartley's phrase "illusions of adequacy." Many other difficulties are evident from the literature (Forrester, 1961; Hartley, 1969; Oettinger, 1969; Silvern, 1965).

The use of such an engineering strategy in an area where there is no well-understood underlying science is hardly consistent with the simplified scientific paradigm from which systems analysis, operations research, and management science supposedly are derived -- repeatable real data first, then tentative mathematical models of the known real phenomena, then analytical experiments with these models, then real experiments with selected cases, then <u>continual improvement</u> through <u>continual interaction</u> of <u>all</u> the four previous steps ad infinitum or until a satisfactory steady state or an insurmountable obstacle is encountered.

The study of feasibility and the planning for future development of GEM have been closely guided by this paradigm. As the first step of the paradigm reaches a certain stage of completeness, the first mathematically trivial models become useful for studies of allocation, utilization, and scheduling, for the optimazation of cost-effectiveness, and for the determination of critical areas of timing and resource competition. Here a computer becomes useful not because of complexity of the simulation model, but because of the large amount of data, the large number of cases which must be examined, and the number of times the calculations must be repeated as conditions change and data becomes more precise. GEM has now reached this stage of development and has a PERT/COST model operating on the University of Georgia IBM 360/65 computer for investigation and management of costs and activity scheduling. Many of the results of this feasibility study have been obtained through use of this model and it will be used in the future on a continuing basis.

In general the creation of simulation models and computer programs in GEM will be for coordinated use both in management and in continuing research and development. It will be carried through three further stages: development of mathematically sophisticated dynamic models of processes and subsystems;

interrelating of these processes and subsystems to form a computerized, adaptive, self-improving overall system simulation model; and continuing operational use of this overall system model, both as a management information, data processing, and control system and as a tool in research for continually improving the system itself and all its processes, components, and subsystems.

In addition, the creation and operation of the overall system model will aid conceptualization, help to assure consistency and completeness of design and smoothness of operation, enable immediate transferrability to other institutions, and facilitate rapid investigation of consequences and implementation of changes due to revised goals, technological breakthroughs, changes in community environment, etc. Some modeling of the environment and some forecasting will also be done, but with emphasis on such practical factors as being prepared to handle children already born or exploring advantages of possible cooperative arrangements rather than on such highly speculative factors as attempting to detail the course of the future or being prepared to utilize likely technological breakthroughs.

The guiding philosophy in these developments will be to increase the power, the flexibility, the rate of improvement

and the stability of operation of the GEM system as rapidly as possible. This will be accomplished by gaining and utilizing new knowledge and understaning while simultaneously striving to lower costs through more effective techniques, better organization and management, and increasing use of cooperative arrangements and automation. Such an operation will be consistently guided by ultimate human and social goals, cost-effectiveness considerations, and a meticulous insistence on an empirical basis for every feature of the system model and a feature of the system model for every important empirical factor.

As the second stage of model design begins to provide viable models of individual processes, new studies will be added to the present cost, allocation, and scheduling investigations. These investigations themselves will be directed toward the outlining of cost-effectiveness tradeoffs and the formulation of policies. For instance, new studies can begin on the concurrence of the empirically-based portions of various models of the teaching-learning process for design purposes while areas of conflict and omission in these models can be documented for research purposes. Meanwhile, use of the first-stage models can be directed toward outlining cost-effectiveness tradeoffs for such alternate processes as paper-and-pencil vs computer-console evaluation of student performance

to aid in formulating policies for the implementation of automation.

As the overall system model becomes operational, studies of interaction effects and system dynamics can begin, both on interactions among components within the system and on interaction of the system with its environment. For instance, within the system there are obvious cost-effectiveness interactions between candidate recruiting procedures, candidate selection criteria, remedial PMs for entering candidates, number of pathways and degree of development of each within the curriculum PMs, elaboration of facilities in remedial clinics, etc. In the environment there are obvious advantages to cooperative arrangements with other institutions in developing and testing PMs, both in combining expert knowledge and in sharing the cost of work or of engaging private contractors where contractors could work more efficiently.

In summary, GEM will proceed to utilize computers and simulation to their fullest cost-effectiveness potential simultaneously in operation and in research while avoiding both the restrictions and dupliations which come from doctrinaire insistence on maintaining an artificial separation between management and research uses of computer simulation models cand the omissions and "illusions of adequacy" which come from too little interaction with empirical facts and

goals. The fundamental scientific paradigm which has guided development and management of GEM thus far has proven itself practical, effective, and economical and has demonstrated itself to be eminently feasible for carrying forth the further development, the implementation, and the sustained operation of the GEM system through creation and use of a computerized overall system simulation model.

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